Mercury Exposure Investigation

Grades

High School

Subject

Science (Chemistry and /or Biology)

Type of Lesson Plan

Project

Suggested Duration

1-2 class periods

Materials

- Copies of *Mercury Fact Sheet*
- Copies of *Site Map*
- Copies of *Patient Profile*
- Copies of *Investigation Record* worksheet / or transparency for the overhead projector

Objectives

TLW…

- Identify sources of mercury exposure given a map of the exposure area and various patient profiles.
- Appreciate the variety of ways humans can come in to contact with mercury.
- Recognize the symptoms of mercury poisoning.

Set

Hand out the ATSDR *Mercury Fact Sheet.* Discuss what a fact sheet is and how it is useful. Read the fact sheet with the class. Identify main points and important facts relating to mercury.

Instructional Input

Form teams of "medical investigators." Teams should be made up of three to four students.
Hand out or place the site map on the overhead projector.
Hand out the case history and patient profiles and have the teams read through them.
Instruct students to think about likely cases of mercury poisoning and possible sources of exposure. Encourage them to use the site map, case history information, and the patient profile in their decisions.

Hand out the *Investigation Record* worksheet and instruct the students to thoughtfully fill it out. Stress the fact that they need to justify their responses based on knowledge gained from the fact sheet and information from the site map, case history, and patient profile.

Closure

Have each group present and defend their results. Come to a class consensus.

Extended Practice

Have the students respond in essay format to the following questions.

- What should be done about the mercury contamination at this site?
- Assuming there is no money available to clean the site up, how could humans be protected from exposure to mercury?
- Attempting to remove the mercury contaminated sediments around the mine, in the river, and in the reservoir can potentially reintroduce mercury, which was previously buried. How would you justify removing, or not removing this sediment?

Case History

Blue River Mine operated as a gold and silver mine for 90 years before closing down operations 20 years ago. The southern portion of the mine site backs up against the Blue River and contains large piles of mining wastes called tailings. The tailings piles have leaked chemicals into the Blue River as well as the groundwater beneath the mine. Mercury is one of the chemicals that is found in the soils around the mine, in the Blue River, and in the groundwater south of the mine.

Ten years ago, Water Town built a dam on the Blue River east of town. Water Town and Dry Town now enjoy inexpensive hydroelectric power as well as recreation on Skinny Reservoir. Over the past ten years, local ecologists have noted an increased number of bear, eagle, owl, hawk, elk, and deer carcasses in the area surrounding the mine, Blue River, and Bird Lake. Biologists and chemists traced the deaths to elevated levels of mercury in the tissues of these animals. Since fish are a main source of food for local predators, the fish populations were tested for the presence of mercury in their tissues. Trout in all the local bodies of water tested positive for unusually high levels of mercury. Bass in Skinny Reservoir contained slightly elevated levels of mercury, while bass in Bird Lake were free of mercury.

Water and sediment samples were collected from Bird Lake, Skinny Reservoir, Blue River, Bird River, and water supply wells. Soil samples were also collected from around the mine. These samples were analyzed by chemists for the presence of mercury. The results are summarized in Table A. Geologists studied the results and determined that the development of the reservoir stirred up sediments in Blue River releasing mercury which had accumulated for 110 years and until recently was buried by sediment. As water from upstream enters the reservoir, it slows down and the mercury falls to the bottom and is covered with sediment and decaying organic matter.

TABLE A

Contaminant	Bird Lake	Bird River	Mine	Blue River	Skinny Reservoir	Well Water
Inorganic Mercury	None	None	High Levels	Moderate Levels	Moderate Levels	Moderate in contaminated wells – see site map.
Methylmercury	None	None	Moderate Levels	High Levels	Low Levels	None

The local wheat field is irrigated with mercury contaminated water. This field supplies the flourmill and bakery in Water Town. This bakery supplies many residents of Water Town with various baked goods. The bakery ships flour and baked goods to communities within a 100 mile radius of water town.

Local health officials have been alerted to the fact that humans could be exposed to mercury through various pathways. Patients admitted to the local hospital are being interviewed to determine if they have been exposed to mercury. Attached is a patient profile sheet for various patients admitted to the hospital in a 24 hour period.

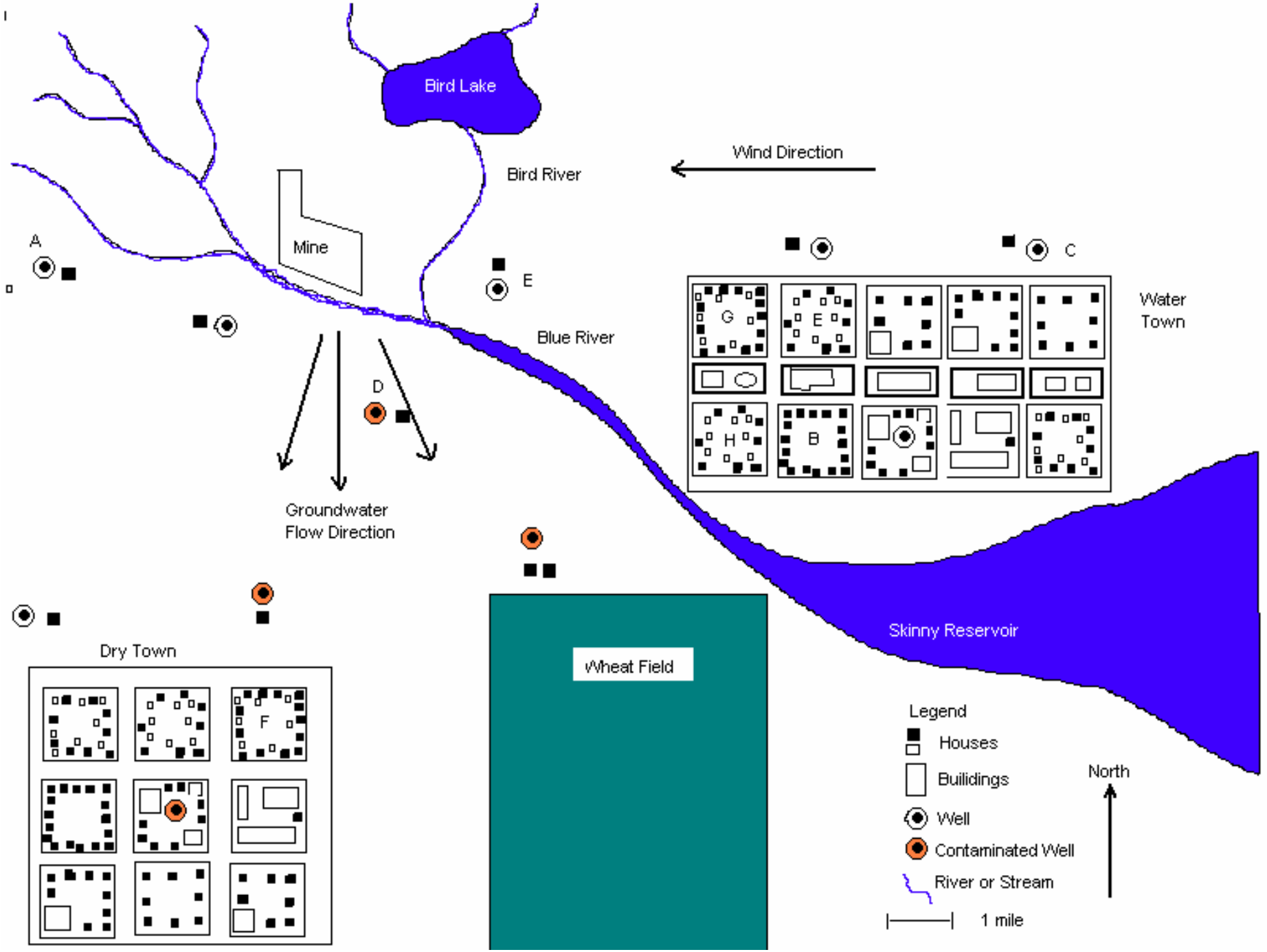
Your task is to identify which patients may have been exposed to harmful levels of mercury, how they may have been exposed, and if other people who share common traits with these patients should be screened for possible mercury poisoning.

Patient Profile – Place of residence is listed on the map according to patient letter.

Patient	Symptoms	Age	Sex	Others in Residence	Occupation	Recreation Activities	Diet	Water Supply
A	Seizures	3 months	M	Mother, Father, two brothers	Infant	None	Breast fed	Domestic well water
B	Chronic fatigue	15	M	Mother, brother, and sister	Student	Baseball, track	Mostly "Junk" food. Few vegetables or fruits	Municipal well water from Water Town
C	Kidney damage, change in vision	50	F	Husband, the last of three children moved out 10 years ago.	Flour Mill worker – 30 years.	Biking, walking the dog, and aerobics	Healthy. Fruits, vegetables, meats (Occasional local fish), lots of baked goods from work	Domestic well water
D	Urination problems	65	M	Wife	Retired teacher	Avid camper, hiker, and hunter – North of Blue River, west of Bird River	Meat and potatoes some fruit and grains. Deer and Elk. No fish.	Domestic well water
E	Coughing and shortness of breath	35	M	Wife and 2 daughters	Auto mechanic	Fishing (bass only) and boating in Bird Lake	Meats, starches, Fruits and vegetables, fish (bass only)	Domestic well water
F	Mood swings, loss of hearing	41	F	Mother, husband, and son	Accountant	Fly fishing (trout) in the blue river and riding jet skis in the reservoir	Healthy. Meats, organic fruits, vegetables, and grains, local trout	Municipal well water from Dry Town well.
G	Acting out in school, memory problems	11	M	Mother, sister	Student	Soccer, skateboarding, building a bmx track near the mine	Meats and starches. Refuses to eat most vegetables. Loves candy	Municipal well water from Water Tow
H	Shaking, socially withdrawn recently	10	M	Mother, Father	Student	Water skiing, bmx, building the track with Patient G	Very healthy. Mother is a nutritionist	Municipal well water from Water Town

Investigation Record NAMES_____Period_____Date_____

Patient	Based on their **symptoms**, do you think this patient was exposed to mercury? Why or why not?	Based on occupation, recreation, diet, water supply, do you think this patient was exposed to mercury? If so, explain **all possible** sources of exposure to mercury for this patient.	Should others in this household be screened for mercury exposure? Why or why not. Keep in mind the possible sources of exposure.
A			
B			
C			
D			
E			
F			
G			
H			


Bird Lake
Bird River
Wind Direction
Mine
A
E
C
Blue River
Water
Town
G
E
H
B
D
Groundwater
Flow Direction
Skinny Reservoir
Dry Town
F
Wheat Field
Legend
Houses
Builidings
Well
Contaminated Well
River or Stream
1 mile
North

Investigation Record NAMES **KEY – other answers on the back**

Patient	Based on their **symptoms**, do you think this patient was exposed to mercury? Why or why not?	Based on occupation, recreation, diet, water supply, do you think this patient was exposed to mercury? If so, explain **all possible** sources of exposure to mercury for this patient.	Should others in this household be screened for mercury exposure? Why or why not. Keep in mind the possible sources of exposure.
A	Yes. Seizures are a symptom of mercury exposure.	Yes. This child was breastfed. If the mother is exposed, she could have passed mercury to her child through breast feeding and in vitro prior to birth.	The whole family should be screened. They live down wind of the site and could be exposed to dust particles containing mercury
B	No. Symptoms don't match mercury exposure.	No. No identifiable exposure from this information.	No. No identifiable exposure from this information.
C	Yes. Kidney damage is a symptom of mercury exposure.	Yes. This patient works at the flourmill and bakery which uses wheat irrigated by mercury contaminated groundwater. Breathing in the flour and eating the baked goods could expose her.	Her husband and children could have been exposed through the baked goods.
D	Yes. Indicates possible kidney dysfunction.	Yes. Ingestion of mercury through consumption of deer and elk flesh. Also, this patient's drinking water well is contaminated with mercury.	The wife should be screened if she consumes elk and deer flesh. Also, this patient's drinking water well is contaminated with mercury.
E	No. Symptoms are not indicative.	No. The patient's well is clean and his activities occur on a clean lake. He consumes fish that is not contaminated with mercury.	No. Same as patient.
F	Yes. Symptoms match those of mercury exposure.	Yes. Dual exposure from trout and water contaminated with mercury.	The entire family should be screened due to dual exposure from trout and water contaminated with mercury.
G	Yes. Symptoms match those of mercury exposure.	Yes. Possible exposure to mine tailings and mercury contaminated soil.	No. No identifiable exposure from this information.
H	Yes. Symptoms match those of mercury exposure.	Yes. Possible exposure to mine tailings and mercury contaminated soil.	No. No identifiable exposure from this information.

Describe any other people in this case that should be screened for mercury exposure. Include the possible sources of exposure involved.

Those to screen next

Flourmill and bakery employees – exposure to contaminated wheat and flour
Consumers of baked goods from the flourmill – exposure to contaminated wheat and flour
Residents of Dry Town who are connected to the contaminated water supply
All residents with contaminated domestic water wells
Residents living west of the mine – exposure to contaminated dust particles blown by the wind
Hunters and fishers and their friends/families that may eat the flesh of fish and game which contains mercury (bass in Bird Lake excluded).
Those recreating around the mine and Blue River – exposure to contaminated soils.
Those consuming exports from the wheat field.